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JONES DAY
222 EAST 41ST ST
NEW YORK, NY 10017

EXAMINER	
WILSON, SCOTT R	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/839,637	AMIN ET AL.	
	Examin r	Art Unit	
	Scott R. Wilson	2826	Aw

-- The MAILING DATE of this c mmunication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 30 December 2003.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-93 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-6,14-21,26,29,31,33,37,39-42,45-51,59-64,80-83 and 86 is/are rejected.

7)☒ Claim(s) 7-13, 22-25, 27-28, 30, 32, 34-36, 38, 43-44, 52-58, 65-79, 84-85, 87-93 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 20 April 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 5 total. 14 May 2001 5 Mar 2003 (5 total) 21 May 2003

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 2, 21, 29, 33 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al.. As to claim 1, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. de Bruyn Ouboter et al. does not disclose expressly that the superconducting loop provides a phase shift. Makhlin et al., Figure 2a, and the text immediately below the figure, discloses a superconducting loop which provides a phase shift. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the superconducting loop of de Bruyn Ouboter et al. with the Josephson junction of Makhlin et al., thereby producing a phase shift in the loop. The motivation for doing so would have been to form a double-well potential, as disclosed by Makhlin et al. (underlined text between Figure 2 and Equation (4)), by coupling the loop via an input loop biased by a current source. The double-well potential is created by suitable choices for the self-inductance of the loop and the bias current. Such an input loop biased by a current source is disclosed in de Bruyn Ouboter et al., Figure 2. Therefore, it would have been obvious to combine Makhlin et al. with de Bruyn Ouboter et al. to obtain the invention as specified in claim 1.

As to claim 2, the multi-terminal junction of de Bruyn Ouboter et al., Figure 2, is a constriction junction.

Claims 3-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Smith et al.. As to claim 3, de Bruyn Ouboter et al. in

view of Makhlin et al. discloses the invention of claim 1, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that the multi-terminal junction includes at least one tunnel junction. Smith et al., col. 4, lines 20-23, discloses a two terminal SQUID loop which include two Josephson tunnel junctions (Figure 3, elements 24 and 26'). At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with tunnel junctions. The motivation for doing so would have been to use standard tunnel junctions well-known in the art to form the multi-terminal junction   Therefore, it would have been obvious to combine Smith et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 3.

As to claim 4, the tunnel junctions of Smith et al. are formed by an insulating layer separating two superconducting sections, which would necessarily be embodied as terminals in the combination of de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Smith et al.

As to claim 5, Smith et al., col. 4, line 30, discloses that the SQUID loop is formed from niobium (Nb), which is known in the art to be an s-wave superconducting material.

Claims 6 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ivanov et al.. As to claim 6, de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 1, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that the multi-terminal junction includes a two-dimensional electron gas structure. Ivanov et al., (Abstract), discloses a three terminal junction, embodied as a Josephson junction, with a semiconducting two-dimensional electron gas layer. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with a two-dimensional electron gas structure. The motivation for doing so would have been to increase mobility and to regulate carrier concentration (Ivanov et al., Introduction, first paragraph). Therefore, it would have been obvious to combine Ivanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 6.

Claims 14-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ryazanov et al.. As to claim 14, de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 1, as described above. de Bruyn Ouboter et

al. in view of Makhlin et al. does not disclose expressly that a portion of the phase shift is produced by a ferromagnetic junction. Ryazanov et al., (Abstract), discloses two superconductors coupled by a ferromagnetic layer, which produces phase shift of from 0 to π, depending on temperature. At the time of invention, it would have been obvious to a person of ordinary skill in the art to produce a portion of the phase shift by using a ferromagnetic junction. The motivation for doing so would have been to produce phase shifts needed in order to form a qubit (Ryazanov et al., page 1, second column, 10th line from bottom). Therefore, it would have been obvious to combine Ryazanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 14.

As to claim 15, the junction disclosed by Ryazanov et al. comprises a first and second portion coupled by a weakly ferromagnetic layer (Abstract).

As to claims 16 and 17, the junction disclosed by Ryazanov et al. comprises a first and second portion formed from Nb (Abstract), which is known in the art to be an s-wave superconductor.

As to claim 18, Ryazanov et al., page 2, right-hand column, 11th line from bottom, discloses that the ferromagnetic junction is formed from a $Cu_{1-x}Ni_x$ alloy.

As to claim 19, although not expressly disclosed by Ryazanov et al., it is understood in the art that the ferromagnetic layer may be implanted.

As to claim 21, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal constriction junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4.

Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ivanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 1, as described above, including the disclosure that the multi-terminal junction is a four terminal junction. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that the multi-terminal junction includes a two-dimensional electron gas structure. Ivanov et al., (Abstract), discloses a three terminal junction, embodied as a Josephson junction, with a semiconducting two-dimensional electron gas layer. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with four terminals, as in de Bruyn Ouboter et al.,

and with a two-dimensional electron gas structure. The motivation for doing so would have been to increase mobility and to regulate carrier concentration (Ivanov et al., Introduction, first paragraph). Therefore, it would have been obvious to combine Ivanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 26.

As to claim 29, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal constriction junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. Each opposing pair of terminals is coupled by a constriction junction.

As to claim 31, the disclosure of de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ivanov et al. would encompass an embodiment in which each terminal is coupled by a two-dimensional electron gas structure.

As to claim 33, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4.

As to claim 37, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. A multi-terminal junction with four terminals would necessarily transport current symmetrically.

Claims 39 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al.. As to claim 39, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a means for coupling a plurality of terminals into a multi-terminal junction with four terminals, labeled 1 through 4, and means for forming a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. de Bruyn Ouboter et al. does not disclose expressly means for providing a phase shift in a superconducting loop. Makhlin et al., Figure 2a, and the text immediately below the figure, discloses means for providing a phase shift in a superconducting loop. At the time of invention, it would have been obvious to a person of ordinary skill in the art to combine the coupling means of de Bruyn Ouboter et al. with the phase shift means of Makhlin et al., thereby producing

a phase shift in the loop. The motivation for doing so would have been to form a double-well potential, as disclosed by Makhlin et al. (underlined text between Figure 2 and Equation (4)), by coupling the loop via an input loop biased by a current source. The double-well potential is created by suitable choices for the self-inductance of the loop and the bias current. Such an input loop biased by a current source is disclosed in de Bruyn Ouboter et al., Figure 2. Therefore, it would have been obvious to combine Makhlin et al. with de Bruyn Ouboter et al. to obtain the invention as specified in claim 39.

Claim 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ivanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 39, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that the coupling means includes a two-dimensional electron gas structure. Ivanov et al., (Abstract), discloses a three terminal junction, embodied as a Josephson junction, with a semiconducting two-dimensional electron gas layer. At the time of invention, it would have been obvious to a person of ordinary skill in the art to provide coupling means to form the multi-terminal junction with a two-dimensional electron gas structure. The motivation for doing so would have been to increase mobility and to regulate carrier concentration (Ivanov et al., Introduction, first paragraph). Therefore, it would have been obvious to combine Ivanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 40.

Claim 41 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Smith et al.. de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 39, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that the coupling means includes at least one tunnel junction. Smith et al., col. 4, lines 20-23, discloses a two terminal SQUID loop which include two Josephson tunnel junctions (Figure 3, elements 24 and 26'). At the time of invention, it would have been obvious to a person of ordinary skill in the art to provide coupling means to form the multi-terminal junction with tunnel junctions. The motivation for doing so would have been to use standard tunnel junctions well-known in the art to form the multi-terminal junction Therefore, it would have been obvious to combine Smith et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 41.

As to claim 42, the multi-terminal junction of de Bruyn Ouboter et al., Figure 2, is a constriction junction.

Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Ryazanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. discloses the invention of claim 39, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. does not disclose expressly that a portion of the phase shift is produced by a ferromagnetic junction. Ryazanov et al., (Abstract), discloses two superconductors coupled by a ferromagnetic layer, which produces phase shift of from 0 to π, depending on temperature. At the time of invention, it would have been obvious to a person of ordinary skill in the art to produce a portion of the phase shift by using a ferromagnetic junction. The motivation for doing so would have been to produce phase shifts needed in order to form a qubit (Ryazanov et al., page 1, second column, 10^{th} line from bottom). Therefore, it would have been obvious to combine Ryazanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. to obtain the invention as specified in claim 45.

Claims 46 and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Han et al.. As to claim 46, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. de Bruyn Ouboter et al. does not disclose expressly that the superconducting loop provides a phase shift. Makhlin et al., Figure 2a, and the text immediately below the figure, discloses a superconducting loop which provides a phase shift. Neither de Bruyn Ouboter et al. nor Makhlin et al. disclose a qubit array comprising a plurality of qubits. Han et al., Figure 5, discloses a qubit array comprising a plurality of qubits. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the superconducting loop of de Bruyn Ouboter et al. with the Josephson junction of Makhlin et al., thereby producing a phase shift in the loop, as well as forming an array of qubits, as in Han et al.. The motivation for doing so would have been to form a double-well potential, as disclosed by Makhlin et al. (underlined text between Figure 2 and Equation (4)), by coupling the loop via an input loop biased by a current source. The double-well potential is created by suitable choices for the

self-inductance of the loop and the bias current. Such an input loop biased by a current source is disclosed in de Bruyn Ouboter et al., Figure 2. Further motivation would have been to form a memory circuit. Therefore, it would have been obvious to combine Makhlin et al. with de Bruyn Ouboter et al. and Han et al. to obtain the invention as specified in claim 46.

As to claim 47, the multi-terminal junction of de Bruyn Ouboter et al., Figure 2, is a constriction junction.

Claims 48-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Han et al., and further in view of Smith et al.. As to claim 48, de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. discloses the invention of claim 46, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. does not disclose expressly that the multi-terminal junction includes at least one tunnel junction. Smith et al., col. 4, lines 20-23, discloses a two terminal SQUID loop which include two Josephson tunnel junctions (Figure 3, elements 24 and 26'). At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with tunnel junctions. The motivation for doing so would have been to use standard tunnel junctions well-known in the art to form the multi-terminal junction Therefore, it would have been obvious to combine Smith et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. to obtain the invention as specified in claim 48.

As to claim 49, the tunnel junctions of Smith et al. are formed by an insulating layer separating two superconducting sections, which would necessarily be embodied as terminals in the combination of de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Smith et al.

As to claim 50, Smith et al., col. 4, line 30, discloses that the SQUID loop is formed from niobium (Nb), which is known in the art to be an s-wave superconducting material.

Claim 51 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Han et al., and further in view of Ivanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. discloses the invention of claim 46, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al.

does not disclose expressly that the multi-terminal junction includes a two-dimensional electron gas structure. Ivanov et al., (Abstract), discloses a three terminal junction, embodied as a Josephson junction, with a semiconducting two-dimensional electron gas layer. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with a two-dimensional electron gas structure. The motivation for doing so would have been to increase mobility and to regulate carrier concentration (Ivanov et al., Introduction, first paragraph). Therefore, it would have been obvious to combine Ivanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. to obtain the invention as specified in claim 51.

Claims 59-64 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Han et al., and further in view of Ryazanov et al.. As to claim 59, de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. discloses the invention of claim 46, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. does not disclose expressly that a portion of the phase shift is produced by a ferromagnetic junction. Ryazanov et al., (Abstract), discloses two superconductors coupled by a ferromagnetic layer, which produces phase shift of from 0 to π, depending on temperature. At the time of invention, it would have been obvious to a person of ordinary skill in the art to produce a portion of the phase shift by using a ferromagnetic junction. The motivation for doing so would have been to produce phase shifts needed in order to form a qubit (Ryazanov et al., page 1, second column, 10th line from bottom). Therefore, it would have been obvious to combine Ryazanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Han et al. to obtain the invention as specified in claim 59.

As to claim 60, the junction disclosed by Ryazanov et al. comprises a first and second portion coupled by a weakly ferromagnetic layer (Abstract).

As to claims 61 and 62, the junction disclosed by Ryazanov et al. comprises a first and second portion formed from Nb (Abstract), which is known in the art to be an s-wave superconductor.

As to claim 63, Ryazanov et al., page 2, right-hand column, 11th line from bottom, discloses that the ferromagnetic junction is formed from a $Cu_{1-x}Ni_x$ alloy.

As to claim 64, although not expressly disclosed by Ryazanov et al., it is understood in the art that the ferromagnetic layer may be implanted.

Claims 80 and 81 are rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., and further in view of Blais et al.. As to claim 80, de Bruyn Ouboter et al., Figure 2, discloses a qubit, embodied as a SQUID, comprising a multi-terminal junction with four terminals, labeled 1 through 4, and a superconducting loop coupled between two of the four terminals, terminal 3 and terminal 4. de Bruyn Ouboter et al. does not disclose expressly that the superconducting loop provides a phase shift. Makhlin et al., Figure 2a, and the text immediately below the figure, discloses a superconducting loop which provides a phase shift. Neither de Bruyn Ouboter et al. nor Makhlin et al. disclose a qubit array comprising a plurality of qubits coupled by an entanglement junction. Blais et al., Figure 1, discloses a qubit array comprising a plurality of qubits, linked by entanglement junctions (first page, top of second column). At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the superconducting loop of de Bruyn Ouboter et al. with the Josephson junction of Makhlin et al., thereby producing a phase shift in the loop, as well as forming an array of qubits, as in Blais et al.. The motivation for doing so would have been to form a double-well potential, as disclosed by Makhlin et al. (underlined text between Figure 2 and Equation (4)), by coupling the loop via an input loop biased by a current source. The double-well potential is created by suitable choices for the self-inductance of the loop and the bias current. Such an input loop biased by a current source is disclosed in de Bruyn Ouboter et al., Figure 2. Further motivation would have been to form a working quantum computation device. Therefore, it would have been obvious to combine Makhlin et al. with de Bruyn Ouboter et al. and Blais et al. to obtain the invention as specified in claim 80.

As to claim 81, the multi-terminal junction of de Bruyn Ouboter et al., Figure 2, is a constriction junction.

Claim 82 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Blais et al., and further in view of Smith et al.. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. discloses the invention of claim 80, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al.

does not disclose expressly that the multi-terminal junction includes at least one tunnel junction. Smith et al., col. 4, lines 20-23, discloses a two terminal SQUID loop which include two Josephson tunnel junctions (Figure 3, elements 24 and 26'). At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with tunnel junctions. The motivation for doing so would have been to use standard tunnel junctions well-known in the art to form the multi-terminal junction Therefore, it would have been obvious to combine Smith et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. to obtain the invention as specified in claim 82.

Claim 83 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Blais et al., and further in view of Ivanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. discloses the invention of claim 80, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. does not disclose expressly that the multi-terminal junction includes a two-dimensional electron gas structure. Ivanov et al., (Abstract), discloses a three terminal junction, embodied as a Josephson junction, with a semiconducting two-dimensional electron gas layer. At the time of invention, it would have been obvious to a person of ordinary skill in the art to form the multi-terminal junction with a two-dimensional electron gas structure. The motivation for doing so would have been to increase mobility and to regulate carrier concentration (Ivanov et al., Introduction, first paragraph). Therefore, it would have been obvious to combine Ivanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. to obtain the invention as specified in claim 83.

Claim 86 is rejected under 35 U.S.C. 103(a) as being unpatentable over de Bruyn Ouboter et al. in view of Makhlin et al., further in view of Blais et al., and further in view of Ryazanov et al.. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. discloses the invention of claim 80, as described above. de Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. does not disclose expressly that a portion of the phase shift is produced by a ferromagnetic junction. Ryazanov et al., (Abstract), discloses two superconductors coupled by a ferromagnetic layer, which produces phase shift of from 0 to π, depending on temperature. At the time of invention, it would have been obvious to a person of ordinary skill in the art to produce a portion of the phase shift by using a

ferromagnetic junction. The motivation for doing so would have been to produce phase shifts needed in order to form a qubit (Ryazanov et al., page 1, second column, 10^{th} line from bottom). Therefore, it would have been obvious to combine Ryazanov et al. with Bruyn Ouboter et al. in view of Makhlin et al. and further in view of Blais et al. to obtain the invention as specified in claim 86.

Allowable Subject Matter

Claim 7 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art expressly discloses a two-dimensional electron gas structure formed from an InAs layer deposited on an AlSb substrate.

Claims 8-13 and 20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a particular embodiment for the superconducting loop, containing a phase-shifting Josephson junction, of any specific combination of s-wave and d-wave superconducting materials.

Claims 22-25, 30 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a four-terminal junction which includes a combination of constriction junctions and tunnel junctions.

Claim 27 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a four-terminal junction which includes a combination of constriction junctions and two-dimensional electron gas junctions.

Claim 28 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a four-terminal junction which includes a combination of tunnel junctions and two-dimensional electron gas junctions.

Claims 32, and 34-36 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a multi-terminal junction with any number of terminals other than four.

Claim 38 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a multi-terminal junction which transports current asymmetrically.

Claims 43 and 44 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a particular embodiment for the superconducting loop, containing a phase-shifting Josephson junction, of any specific combination of s-wave and d-wave superconducting materials.

Claim 52 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art expressly discloses a two-dimensional electron gas structure formed from an InAs layer deposited on an AlSb substrate.

Claims 53-58 and 65 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a particular embodiment for the superconducting loop, containing a phase-shifting Josephson junction, of any specific combination of s-wave and d-wave superconducting materials.

Claims 66-79 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any

intervening claims. No prior art discloses neighboring terminals of multi-terminal junctions coupled to form a series connection. Schopohl et al. is related art, disclosing a high resolution magnetic field sensor, but, as shown in Figure 2c, neighboring superconducting loops share a common Josephson junction directly, as opposed to applicants link between neighboring multi-terminal junctions, with the Josephson junction located elsewhere in the superconducting loop.

Claims 84 and 85 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a particular embodiment for the superconducting loop, containing a phase-shifting Josephson junction, of any specific combination of s-wave and d-wave superconducting materials.

Claim 87 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses a particular embodiment for the superconducting loop, containing a phase-shifting Josephson junction, of any specific combination of s-wave and d-wave superconducting materials.

Claims 88-93 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. No prior art discloses neighboring terminals of multi-terminal junctions coupled to form a series connection. Schopohl et al. is related art, disclosing a high resolution magnetic field sensor, but, as shown in Figure 2c, neighboring superconducting loops share a common Josephson junction directly, as opposed to applicants link between neighboring multi-terminal junctions, with the Josephson junction located elsewhere in the superconducting loop.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Scott R. Wilson whose telephone number is 703-308-6557. The examiner can normally be reached on M-F 8:30 - 4:30 Eastern.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-1782.

srw
April 30, 2004

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800